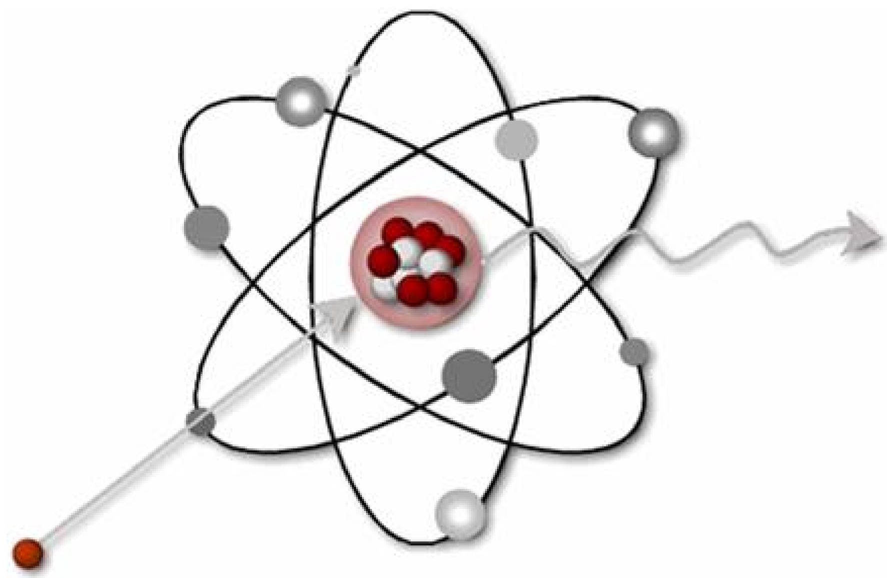
Waste Site Worker Safety

40 Hour HAZWOPER



Radiological Hazards

Module 6

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Acronyms Used In This Module

ALARA	As Low As Reasonably Achievable
Becquerel	Bq
Ci	Curie
CFR	Code of Federal Regulations
DOE	Department of Energy
EPA	Environmental Protection Agency
Gy	Gray
mrem	millirem
MSDS	Material Safety Data Sheet
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
R	Roentgen
Rad	Radiation Absorbed Dose
Rem	Radiation Equivalent Man
TLD	Thermo Luminescent Dosimeter

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Overview

Radiation hazards and monitoring are often the most neglected and misunderstood type of monitoring on the hazardous waste site. For this reason, waste site workers need to have an understanding of radiation hazards and the different types of radiation. This will allow the site supervisor to decide the type of protection necessary for the type of radiation hazard they encounter to protect workers.

Terminal Learning Objective

Participants will demonstrate the utilization of various monitoring devices and equipment and explain the specific limitations of these instruments and devices.

Enabling Objectives

1. Identify potential exposures to various types of radiological hazards.

2. Explain the difference between the three types of radiation.

3. Describe the biological effects of radiation exposure.

4. List monitoring devices to detect radiation.

5. List the three methods of protection from radioactive sources.

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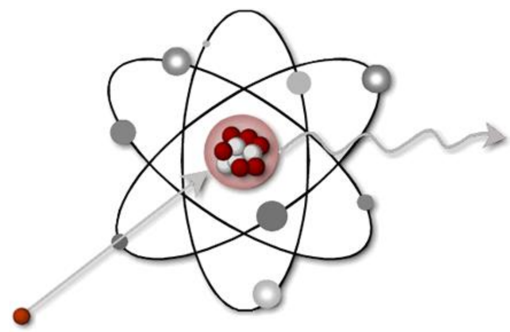
Radiological Hazards

Unlike many of the other hazards present on a hazardous waste site, detection of radiation is solely dependent on monitoring by instrument. Although not commonly considered the primary hazard on most waste sites, radioactive materials may be present in drums, including lab packs, in either solid or liquid form. Waste from hospitals and research facilities, in particular, should be suspected of containing ionizing (see below) radiation. In order to avoid exposure, it is important that workers realize the precautions that must be taken when dealing with radiological waste or sources.

Radiation Energy

Each type of radiation can be emitted with various levels of energy, measured in eV (electron volts). Due to the magnitude of the numbers, energies are usually expressed in KeV (thousands) and MeV (millions). The type of radiation and its energy are unique to the type of radioactive material and can be used to identify it.



Types of Radiation

There are four main types of radiation: alpha, beta, gamma, and neutron.

Alpha (α) Particles

Alpha particles are positively-charged particles consisting of two protons and two neutrons all strongly bound together by nuclear forces. They are the heaviest of the radioactive particles. Alpha particles have a mass about 7,000 times the mass of electrons and are ejected from the nuclei of radioactive atoms with one or several characteristic and discrete energies. Alpha particles are the least penetrating of the three types of ionizing radiation. They do not penetrate the dead layer of skin and can be stopped by a piece of paper or clothing. They are, however, not a "safe" type of radiation. They are energetic particles that transfer their energy over a short distance, doing a great deal of damage. A health hazard may occur when alpha-emitting materials are inhaled or swallowed, or enter the body through a wound, depositing themselves near or in cells where the energetic alpha particles will do extensive damage when released. Thus, alpha particles are essentially an internal hazard only.

Beta (β) Particles

Beta particles are high-speed charged particles with a moderate penetrating power. These particles have the characteristics of electrons and are negatively charged. Beta particles can travel several hundred times the distance of alpha particles in the air and can penetrate into skin and cause severe skin burns. They require fairly thin (a few millimeters) shielding such as thin metal, wallboard, or heavy clothing to stop them. Thus, beta particles can be an external and an internal hazard because they can injure from both the outside and inside of the body.

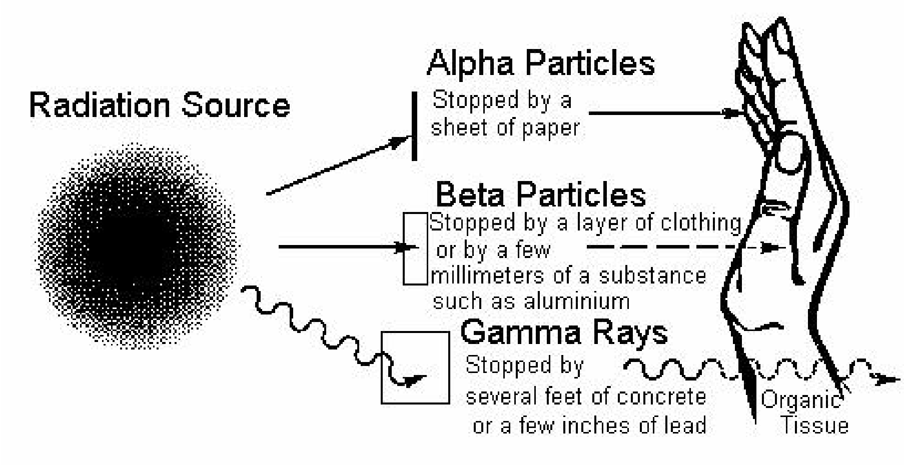
Like alpha particles, beta particles may damage internal organs if ingested by eating, drinking, or breathing contaminated materials. Beta-emitting contamination also can enter the body through unprotected open wounds or the lens of the eye.

Gamma (γ) Rays

Gamma rays are electromagnetic radiation emitted from the nucleus of a radioactive atom. Gamma rays are the most penetrating type of radiation and can travel many meters to miles in air and deeply into tissue, doing damage to tissues and deep organs. Like emitters of beta particles, gamma rays constitute an internal and an external hazard.

Neutron

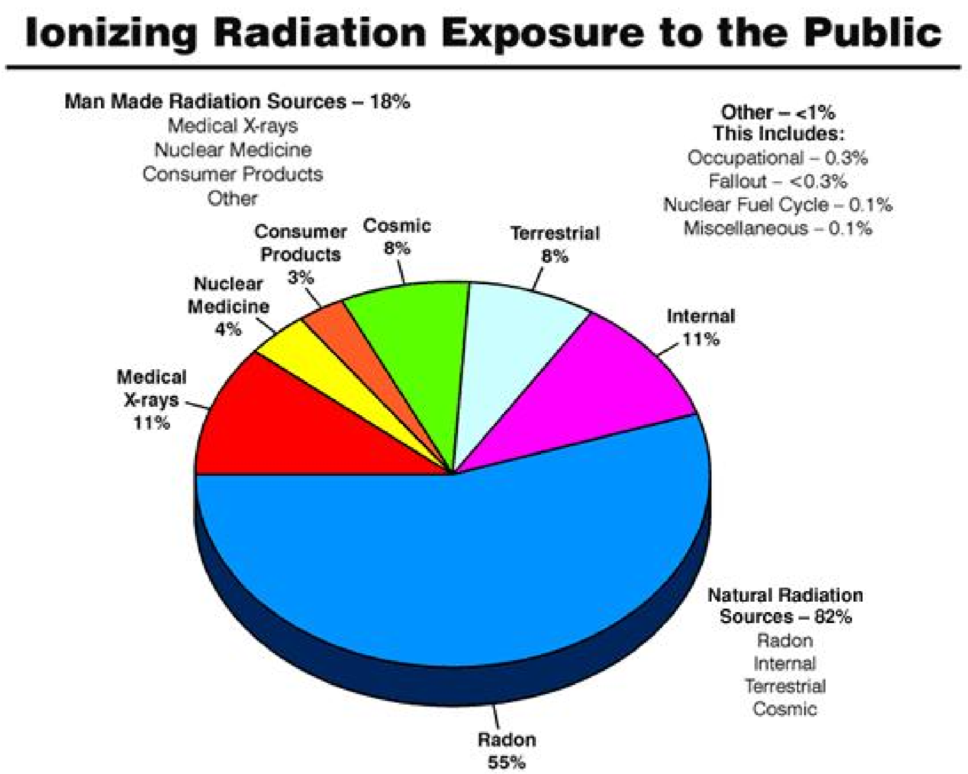
The neutron is an uncharged particle having a mass similar to that of a proton, approximately equal to the masses of a proton and an electron. They interact directly with atomic nuclei. Because of their mass and energy, neutrons can cause severe disruptions in atomic structure. (In addition, they have the ability to convert stable isotopes to radioisotopes.) Neutron radiation is significant mainly in nuclear fuel, weapons and research types of facilities.



Sources of Radiation

There are many sources of natural and human-made radiation to which we are exposed every day, including:

- Cosmic radiation from the sun.
- Terrestrial radiation from radioactive elements in the earth.
- Radioactivity in the body (e.g. radioactive carbon and potassium).
- Diagnostic radiology (e.g. x-rays).
- Therapeutic radiology (e.g. for cancer treatment).
- Fallout from weapons testing. Radioactive materials that enter the atmosphere from weapons tests circulate around the earth and return to earth over a period of years.
- Occupational exposure in certain industries.



The above chart is taken from the National Council on Radiation Protection and Measurements (NCRP) Report No. 93, "Ionizing Radiation Exposure of the Population of the United States," 1987.

This chart shows that natural sources of radiation account for about 82% of all public exposure while man-made sources account for the remaining 18%.

Natural sources are cosmic radiation and terrestrial radiation. A five-hour air flight will expose a passenger to about 65 microsieverts (6.5 millirems). Radon accounts about three-quarters of the natural radiation exposure. In addition, everyone is exposed to man-made sources, the best known of which are those related to medical sources, although consumer products such as smoke detectors (Americium-241) and luminous dials (Tritium or Promethium-147) also contribute to exposure.

Radiation and Exposure Measurements

There are several ways to express measures of radiation:

- **Roentgen**: Roentgen is the unit used to express the amount of gamma radiation exposure an individual receives (e.g. 50 R). This measure is independent of the time over which the exposure occurs. That is, if a person is exposed to 5 R of gamma rays on one occasion and 6 R on another, the person's cumulative gamma radiation exposure is 11 R.

- **Radiation Absorbed Dose (Rad)**: Rad is the unit used to express the amount of energy absorbed from exposure to radiation. (Different materials may absorb different amounts of energy from the same exposure.) The dose of one rad indicates the absorption of 100 ergs per gram of absorbing material. One roentgen of gamma radiation exposure results in about one rad of absorbed dose.

- **Roentgen Equivalent Man (Rem)**: Some types of nuclear radiation produce greater biological effects than others for the same amount of energy imparted. The rem is a unit that relates the dose of any radiation to the biological effect of that dose. For gamma rays and beta particles, 1 rad of exposure results in 1 rem of dose. For alpha particles, 1 rad of exposure results in approximately 20 rem of dose.

  For the general population, national guidelines recommend dose limits of 0.5 rem/year. International guidelines set dose limits of 0.5 rems/year for short-term exposure and 0.1 rems/year for long-term exposure.

- **Exposure Rate**: The exposure rate is the exposure per unit of time. It is usually expressed as roentgen or milliroentgen per hour (e.g. 60 R/hr). The exposure rate is commonly used to indicate the level of hazard from a radioactive source.

- **Radioactivity**: The radioactivity of a given material is a measure of the rate at which the material undergoes radioactive decay. The unit of measure for radioactivity is the curie (Ci). Specific activity is the amount of radioactivity per unit mass, typically measured in units of curies per gram (Ci/g).

The following table provides the most current conversions for radiological units. Note that the Becquerel (Bq) has replaced the curie (Ci); the gray

(Gy) has replaced the rad; Coulomb/Kg replaces the roentgen; and the sievert (Sv) has replaced the rem.

The curie (Ci) is replaced by the becquerel (Bq)* 1 kilocurie (kCi) = 37 terabecquerel (TBq) 1 curie (Ci) = 37 gigabecquerel (GBq) 1 millicurie (mCi) = 37 megabecquerel (MBq) 1 microcurie (µCi) = 37 kilobecquerel (kBq) 1 nanocurie (nCi) = 37 becquerel (Bq) 1 picocurie (pCi) = 37 millibecquerel (mBq)	**Becquerel (Bq)* replaces the curie (Ci)** 1 terabecquerel (TBq) ~ 27 curie (Ci) 1 gigabecquerel (GBq) ~ 27 millicurie (mCi) 1 megabecquerel (MBq) ~ 27 microcurie (µCi) 1 kilobecquerel (kBq) ~ 27 nanocurie (nCi) 1 becquerel (Bq) ~ 27 picocurie (pCi) * 1 Bq = $1s^{-1}$
The rad (rad) is replaced by the gray (Gy) 1 kilorad (krad) = 10 gray (Gy) 1 rad (rad) = 10 milligray (mGy) 1 millirad (mrad) = 10 microgray (µGy) 1 microrad (µrad) = 10 nanogray (nGy)	**The gray (Gy) replaces the rad (rad)** 1 gray (Gy) =100 rad (rad) 1 milligray (mGy) = 100 millirad (mrad) 1 microgray (µGy) = 100 microrad (µrad) 1 nanogray (nGy) = 100 nanorad (nrad)
The roentgen (R) is replaced by coulomb/kg (C/kg) 1 kiloroentgen (kR) ~ 258 millicoulomb/kg (mC/kg) 1 roentgen (R) ~ 258 microcoulomb/kg (µC/kg) 1 milliroentgen (mR) ~ 258 nanocoulomb/kg (nC/kg) 1 microroentgen (µR) ~ 258 picocoulomb/kg (pC/kg)	**Coulomb/kg (C/kg) replaces the roentgen (R)** 1 coulomb/kg (C/kg) ~ 3876 roentgen (R) 1 millicoulomb/kg (mC/kg) ~ 3876 milliroentgen (mR) 1 microcoulomb/kg (µC/kg) ~ 3876 microroentgen (µR) 1 nanocoulomb/kg (nC/kg) ~ 3876 nanoroentgen (nR)
The rem (rem) is replaced by the sievert (Sv) 1 kilorem (krem) = 10 sievert (Sv) 1 rem (rem) = 10 millisievert (mSv) 1 millirem (mrem) = 10 microsievert (µSv) 1 microrem (µrem) = 10 nanosievert (nSv)	**The sievert (Sv) replaces the rem (rem)** 1 sievert (Sv) = 100 rem (rem) 1 millisievert (mSv) = 100 millirem (mrem) 1 microsievert (µSv) = 100 microrem (µrem) 1 nanosievert (nSv) = 100 nanorem (nrem)

Routes of Exposure

Radiation exposure can occur through four primary routes:

- Absorption: Some kinds of radiation can be absorbed directly into the body through the skin. Clothing provides some protection, especially in the case of light exposure. Contaminated clothing should be removed to prevent the radioactive particles from transferring to the body.

- Inhalation: Radioactive particles can be inhaled. Radioactive particles that are breathed into the lungs not only provide a direct dose of radiation, but they can concentrate in particular organs (e.g. lungs, bones, or thyroid).

- Ingestion: Radioactive particles may be ingested if a person's hands become contaminated and then the person fails to decontaminate before eating. Radioactive material may also be ingested if water or food supplies become contaminated, or if radioactive particles deposited on the ground are eaten by grazing cattle whose meat or milk is consumed by the public. Careful monitoring of water and food supplies is required after a radiological incident.

- Injection: Radioactive particles can enter the body through breaks in the skin through open wounds, or if contaminated shrapnel cuts into the skin.

Dose Rates

Radiation units include a time factor, and are commonly referred to as dose rates. These can be expressed as follows:

- R/hr or mR/hr (mR/hr is 1/1000th or 10–3 of the unit R/hr)
- rad/hr or mrad/hr
- rem/hr or mrem/hr
- Radiation dosage

When we talk in terms of dosage in radiation, we use the same terms found in toxicology: amount of exposure times the duration of exposure (quantity x time). We also classify radiation doses as acute or chronic.

Chronic Dose

Chronic doses are small amounts of radiation over a long period of time, such as our normal daily exposures over our lifetimes. We know that the body is able to tolerate a chronic dose better than an acute dose.

Chronic Radiation Exposure

Chronic radiation exposure involves low levels of ionizing radiation over a long period of time. Among the possible effects of chronic exposure are the increased risk of developing cancer and cataracts. In addition, research indicates possible genetic effects in humans from radiation damage to sperm and egg cells. Genetic damage may result in birth defects; furthermore, an exposed worker's genetic effects may be passed along to future generations. The potential for chronic exposure to ionizing radiation is measured in mRem over many days time. OSHA's ionizing radiation standard is in 29 CFR 1910.96.

Acute Dose

Acute doses have a greater effect on us because the body does not have time to repair or replace the damaged body cells. An acute dose of 10,000 - 25,000 mrem could cause slight blood changes, but a normal individual would not be otherwise affected. An acute dose greater than 100,000 mrem causes half of the exposed population to experience nausea (due to damage to the intestinal lining). This is common in radiation therapy patients. Acute doses greater than 500,000 mrem may cause so much body damage that the body cannot recover. For example, the firefighters at Chernobyl are estimated to have received doses in excess of 800,000 mrem. This, compounded with the burns they received, caused them to succumb to the effects of their injuries.

Acute radiation exposure

Acute radiation exposure is the result of a large dose in a short period of time. An acute exposure, where recovery is probable, includes the following possible effects: lowering of the white blood cell count, nausea, bacterial infections, vomiting, loss of appetite, reddening of the skin, diarrhea, fatigue, hair loss, and possible sterility.

In a more severe exposure, the victim may suffer fever, abdominal pains, explosive diarrhea, internal bleeding, infection, shock, convulsions, coma, and ultimately death. Acute exposure is usually considered to be 25 Rem over 24 hours time.

Dose Limits

Dose Limits represent the maximum permissible radiation dose equivalent an individual is allowed to receive. They should never be considered desirable dose equivalent levels. EPA has established a recommended action limit of 1 mrem/hr. EPA states that investigation and monitoring may continue as readings increase above background radiation levels. However, at the action level of 1 mrem the area should be vacated, the boundary clearly marked, and a health physicist employed. Department of Energy (DOE) limits are the same as those established for all federal agencies by the Environmental Protection Agency.

Radiation Exposure

Radio sensitivity is a term which describes how sensitive a given cell is to radiation damage. Scientists have found that the faster a cell reproduces the more sensitive it is to radiation. The following cells are considered to be the most radiosensitive because of their reproductive rate:

- Cells of the unborn child.
- Blood and blood-producing organs.
- Reproductive cells (sperm/egg).
- Digestive tract cells.
- Immature white blood cells.

Those that reproduce slowly and are considered the least radiosensitive are nerve, muscle and bone cells. Of course, radiation affects each person differently depending on such factors as age, medical history, and physical and mental condition. As with chemical exposure, the effect of radiation exposure may be acute or chronic.

Comparison of Radiation Health Risk

The following table compares the estimated loss of life expectancy due to radiation as compared to other health risks.

Average Estimated Days Lost Due To Daily Activities

HEALTH RISK	AVERAGE ESTIMATED DAYS LOST
Unmarried Male	3500
Cigarette smoking (1 pack/day)	2250
Unmarried female	1600
Coal miner	1100
25% overweight	77
Alcohol (U.S. average)	365
Construction worker	227
Driving a motor vehicle	207
100 mrem/year for 70 years	10
Drinking coffee	6

This next table addresses the estimated days lost of life expectancy due to radiation exposure at radiation-related facilities as compared to other industries.

Average Estimated Days Lost Due To Work Activities

HEALTH RISK	AVERAGE ESTIMATED DAYS LOST
Mining / Quarrying	328
Construction	302
Agriculture	277
Radiation dose of 5,000mrem/year for 50 years	250
Transportation/Utilities	164
All industry	74
Government	55
Service	47
Manufacturing	43
Trade	30
Radiation accidents(deaths from exposure)	<1

Radioactive Contamination

Radioactive contamination can be in the form of any of the three states of matter: solid, liquid, or gas. Solid contamination is usually in the form of very small particles such as dirt or dust. These are most commonly found on the floor, ground, and other surfaces. Liquids may be contaminated with suspended or dissolved radioactive solids. Radioactive gases produced in some processes have the potential for leaking via ruptures or failures in containment systems and storage vessels. Radioactive contamination may be fixed or transferable.

Fixed Contamination

Fixed is not easily transferred from one place to another. It usually becomes fixed by physical or chemical absorption or by entrapment in physical irregularities of the surface material.

Transferable Contamination

Transferable contamination, on the other hand, is easily removed; any object that makes contact with it will in turn become contaminated. Cleanup activities where radioactive dust or dirt is present may lead to airborne contamination due to the mechanical action of the sweeping or bagging activities. Examples of transferable contamination include (1) surface contamination, which can be spread by contact; (2) airborne contamination, which can be spread by grinding or burning, by air currents, and by evaporation; and (3) hot particles, which are small pieces of radioactive material with a very high radioactivity level. Hot particles may be especially hazardous to the skin or the extremities due to their short range and the intensity of the radiation emitted.

If a worker becomes contaminated, a health physicist should be consulted for proper decontamination procedures. The process is NOT the same as chemical decontamination. The decontamination methods used depend upon the location and the form of the contamination. Normal cleaning techniques for external decontamination usually involve washing with soap and lukewarm water, although the aid of other techniques and medical personnel may be needed. Reduction of internal contamination depends on the radioactive half-life of the particular contaminant and the normal biological elimination processes such as urination, exhalation, defecation, and perspiration. These processes can be enhanced under proper medical supervision. The removal of radioactive materials from one location simply means their displacement to another location.

Radiation Protection

A human cannot sense if a material is giving off radiation. Radiation must be detected and measured using radiation monitoring instruments. It is vitally important that each drum, container, and area be checked for ionizing radiation. Containers must also be checked as they are opened. Remember, that on a waste site, containers may be unmarked or improperly marked.

Health Effects

The radiation concerns at an incident involve whole-body exposure.

- Internal exposure by the intake of radioactive material through the respiratory and digestive tracts.

- External exposure by contamination of radioactive material exposure.

The dose is the total amount of radiation received. The larger the dose received, the greater the health risk becomes. The dose rate is the length of time over which the dose is received. Dose rate exposures are categorized as either acute or chronic.

Acute Exposure

Acute exposures are large doses occurring over a short period and normally pose a high health risk with symptoms occurring within hours or days. Symptoms of acute radiation exposure include skin burning, vomiting, and indigestion.

Chronic Exposure

Chronic exposures are small doses occurring over a long period and normally pose a smaller health risk with symptoms (tumors, etc.) delayed for years.

Alpha and beta emitters generally pose only internal exposure hazards. Gamma radiation, however, poses an external hazard for a distance of hundreds of feet.

Symptoms

In most instances, it takes a considerable amount of time before someone exhibits symptoms of radiation poisoning. There are exceptions, however. If a person were to handle an active radioactive source, he or she could receive radioactive skin burns, which could develop in a matter of hours.

General Principles

Emergency responders should always use proper priorities in caring for victims where potential radiation hazards exist. The first concern to be addressed by responders is that of treating life-threatening problems. The second concern that must be addressed is that of limiting exposure to victims and responders. Finally, one should do all that is possible to limit any further spread of contamination.

Before initiating plans for rescue, one should always assume that all property and personnel are contaminated. Approach to the site should always be made with caution, surveying for evidence of radioactive materials as entry into the scene is made. One must always rule out the presence of radiation.

An acute exposure of 450 R over a very short period of time would lead to a 50 percent mortality rate for the exposed people within one month without medical treatment. Acute radiation exposure over 100 R within a short period of time can lead to acute radiation sickness. The likelihood of death depends upon the individual. Depending on the dose, acute radiation sickness symptoms can include the following:

- Changes in the blood cells

- Vascular changes
- Skin irritation and burns
- Gastrointestinal effects
- Radiation sickness – diarrhea, nausea, vomiting, high fever
- Hair loss

Radiation Exposure vs. Contamination

Exposure to radiation occurs when a person or an object is close enough to radioactive material, without touching it, to be affected by it. Contamination takes place when contact is made with radioactive material and it is deposited on the skin, clothing, etc.

Contamination

A person exposed to radiation, but not actually touching the substance emitting the radiation, will not be contaminated. A person who is contaminated will be exposed to radiation.

Contamination can be further spread by people or animals walking across contaminated surfaces and collecting contaminated dirt on their shoes or feet, or on the wheels of vehicles. It must also be remembered that all water and food exposed to the radioactive material could become contaminated; if consumed, this could lead to internal contamination, which will expose internal organs to radiation until the contamination passes from the body. Contaminated plants and animals cannot be consumed.

Control zones must be established to prevent unauthorized access to contaminated areas. These should be established as soon as possible after the event and maintained until the area has been decontaminated.

A Hot Zone is normally established at the 1 to 2 mR/hr line. All individuals, materials, and equipment leaving the Hot Zone must be monitored and decontaminated before going into the clean zone. This is done in the Warm Zone, which is established around the Hot Zone. All items, such as contaminated clothing, must be safely bagged and secured in the decon area.

Surface contamination can be removed from people and equipment by washing. Everyone and everything must be checked after decontamination has been performed. Do not forget the soles of feet!

The zones should be established by trained personnel only.

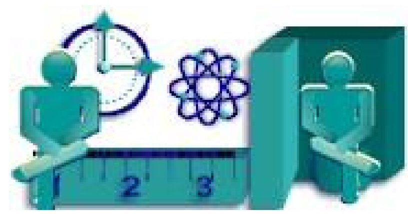
Elements of Radiation Protection

ALARA

This principle states that all efforts be aimed at keeping the radiation exposure **A**s **L**ow **A**s **R**easonably **A**chievable. By using these radiation protection principles, emergency department personnel can adequately care for the patient's medical needs while minimizing their own radiation exposure. All activities should be guided by the ALARA concept.

There are three basic radiation protection principles that can be employed to reduce exposure to ionizing radiation. These principles are based on consideration of three radiation protection factors that alter radiation dose:

- Time
- Distance
- Shielding



Time

The radiation dose is reduced in proportion to the reduction of exposure time; therefore, one should work toward reducing exposure time. Avoid any unnecessary exposure and know that radiation cannot be physically sensed. Time is an important factor in radiation protection. This principle states that the shorter the time spent in a radiation field, the less radiation that is absorbed by the body. Depending on the activity present, radioactive material will emit a certain amount of radiation per unit time. Obviously, the longer a person remains in a radiation field, the more radiation the person will absorb into the body.

Distance (Inverse Square Law)

The inverse square law states that the radiation dose rate changes inversely by the square of the change in the distance. For example, the dose rate at three feet is 20 R/hr. Increase the distance by a factor of two (to six feet), the dose rate decreases by a factor of 2^2 or four, and the dose rate is five R/hr. Triple the distance from three to nine feet, and the dose decreases by a factor of 3^2 or nine. The dose rate would then go from 20 R/hr to 2.2 R/hr. It also works in reverse - decrease the distance to *½,* and the dose rate quadruples. Go from six to three feet, and the dose rate goes from five to 20 R/hr.

The farther a person is from the source of radiation, the lower the radiation dose. While alpha particles only travel a little over an inch in air and beta particles will travel only a few yards in air, gamma rays will travel extensive distances. As a result, gamma rays pose the greatest threat of exposure. Responders will receive a smaller dose of radiation by moving away from the source. In the case of gamma rays, the intensity decreases in proportion to the square of the distance.

Shielding

Various materials can serve as shielding, depending on the type of radiation. Alpha cannot penetrate unbroken skin or even paper. Alpha travels approximately one to two inches in air. Beta radiation is easily stopped by clothing or aluminum foil; it travels approximately 10 to 15 feet in air and can penetrate only a few millimeters of tissue. Gamma rays are only reduced by dense materials such as lead or earth.

Gamma travels hundreds of meters in open air and can easily penetrate the human body.

The denser a material, the greater is its ability to stop the passage of radiation. In most cases, high-density material such as lead is used to shield from radiation. Portable lead or concrete shields are sometimes used when responding to accidents where contamination levels are very high. Some specialty centers for radiation accident management have constructed shielded surgical tables for protection.

In emergency management of the contaminated patient, shielding is limited to standard surgical clothing with slight modifications. Surgical clothing will protect the individual against contamination and will also stop the passage of all alpha and some beta radiation. However, it does not stop penetrating gamma radiation. In the hospital emergency department, shielding is limited to anti-contamination measures, and the principles of time and distance are used to reduce radiation exposure. Lead aprons used by x-ray departments are only partially effective as they are too thin.

Detection

Radiation is invisible and the effects are delayed, possible by years. It can be detected and measured only with the use of instruments. The use and interpretation of these instruments requires training. Detection of radiation can only be made using instruments built for that purpose. Almost all radiation detection instruments measure radiation in dose rates (the amount of radiation absorbed per unit of time [i.e., 50 mrem/hr]).

Some instruments, however, will measure the total exposure dose (the total amount of exposure occurring; i.e., 50 mrem). Because the possibility exists, checking for the presence of radiation as part of a CBRNE event response is recommended.

Because alpha and beta radiation have little penetrating potential, their main threat results from the possibility of inhalation or ingestion in the form of dust or contaminated food or water. Employing high efficiency particulate air (HEPA) filters can eliminate the respiratory threat.

Environmental Monitoring

Environmental monitoring of airborne particulates is performed using high volume, high efficiency filter or impact air samplers. The particulate samples are then evaluated using standard survey meters.

For personal exposure the normal instruments are pocket ionization chambers, thermo luminescent dosimeters (TLDs) and film dosimeters.

- CDV-700 Survey Meter. This meter has a detection range of 0 to 50 mR/hr and is most useful in a decontamination area. It is designed to measure gamma radiation and, with the probe window open, it will detect high energy beta. Note: It may saturate in areas of high radiation.

- CDV-715 Survey Meter. This meter has a higher range from 0 to 500 R/hr. As such it would be used in an area of unknown radiation, and can be used in tandem with the CDV-700. It detects only gamma radiation.

- CDV-718 Survey Meter. This meter has a range from 0 to 10,000 R/hr and has a digital readout. The advantage of this instrument is that it can be set to alarm when either a preset dose rate or accumulated dose has been reached

- Eberline RO-20 Survey Meter. This meter has a range from 0 to 50 R/hr. This meter measures gamma radiation, or with the window open it can measure beta.

- Ludlum Model 3 with 44-9 GM Pancake Probe. The range is 0 to 300 mR/hr and is most useful for checking for contamination at the contamination control point for people leaving a contaminated area and passing through decon. This meter detects alpha, beta and gamma. Be careful not to contaminate the probe.

- Ludlum Model 19 Micro R Meter. This meter detects 0 to 5,000 microR/hr and is useful for finding small sources or radiation.

The use of all of this equipment requires training.

Radiological Decontamination

- Wet down the person; this allows the radioactive material (contamination) to adhere to clothing and skin, thus reducing the airborne hazard and the potential for ingestion and/or inhalation.
- Strip or cut away contaminated clothing.
- Flush with large amounts of water (use soap if available) to remove any remaining contamination from skin and hair.
- Cover for protection and modesty.

NOTE: During decontamination, every effort should be made to control runoff. If runoff control is not possible, notify the appropriate agencies as soon as it is possible.

Review Questions

1. List at least two sources of exposure to radiological hazards.

2. How do the four types of radiation differ?

3. List some of the biological effects of radiation exposure.

4. What can be done to protect yourself from radiation exposure?